Waste Not

Environmental solutions for California's dairy industry

A preliminary assessment of alternative business models

April 2013

Sustainable Conservation

CEA California Environmental Associates

Executive summary

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Introduction

Project description

In the spring of 2013, Sustainable Conservation and California Environmental Associates (CEA) embarked on an effort to take a broad look at the range of opportunities to reduce methane and nitrogen pollution from California dairies in ways that are positive additions to the dairy business model. On behalf of Sustainable Conservation, CEA worked to identify potential solutions and conduct a preliminary evaluation of their viability in California. This evaluation was intended to scan the landscape and provide a high level overview of opportunities. A comprehensive survey of economic feasibility was beyond the scope of the project. The findings presented here are preliminary. The objective is to help inform the dialog among participants at the Summit. CEA's final report for Sustainable Conservation will incorporate key take-aways from the Summit.

Objective

The goal of this project were manifold:

1) To identify the suite of options that might reduce both methane and nitrogen pollution from dairies, and that might be profitable for the industry.
2) To develop a preliminary understanding of the viability of each opportunity, including the key drivers and barriers to implementation, and to help identify some near-term opportunities for the industry and its stakeholders.
3) To inform the agenda and discussion at Sustainable Conservation's Dairy Summit.
4) To inform and support next steps that Sustainable Conservation and others might take to help speed the development of any of the business models reviewed.

Introduction

Methodology

CEA conducted many interviews with experts both in and out of California and augmented interview takeaways with a literature review of existing studies and reports.

In the first phase of the project, CEA sought to identify any potential opportunity to reduce the environmental impact of dairies in California that could be profitable for the dairies, but that has not already been widely adopted.

The second step was to conduct a preliminary vetting of these opportunities. The intent for this phase of work was not to develop a comprehensive and exhaustive assessment of each opportunity, but rather to get a first order sense of the technical and economic viability and likely barriers. This assessment included a review of the underlying economics of the business model, regulatory hurdles, technology risk, required infrastructure investments, capital investment requirements, and applicability to California.

The preliminary findings of this assessment are included in this report and have been used to help frame the agenda for Sustainable Conservation's Dairy Summit on May 9-10, 2013.

CEA's final report for Sustainable Conservation will incorporate key take-aways from the Summit.

Summary of draft findings

High level summary: The most promising models focus on improving profitability by either (or both) increasing the scale of outputs or expanding the product line (creating fiber and fertilizer products). Associated challenges include managing greater business complexity and introducing new materials into the system, which can create new nutrient management issues and regulatory hurdles.

Expanding project scale/productivity:

Standard digester models - Opportunity remains for limited players who have 1) access to low cost capital, 2) ability to aggregate multiple dairy projects to improve economies of scale, and/or 3) expertise in the power/utility industry.

Expanded digester models – Promising opportunities exist for co-digestion at both small and large scales. Large scale co-digestion could be transformative by spanning industries – transforming waste streams from the dairy industry and larger agricultural, food, or other organic producers in California into renewable power.

Diversifying product line:

Compost and fiber – Dairies can repurpose digester solids to deliver value beyond bedding cost avoidance. There is potential in this market for technologies that can be widely applied to both large and small dairies.

Nutrient capture – Though technologies are still at an early stage, pairing a regulatory driver with business value could foster investments to drive innovation. Nutrient products (fertilizers and or high quality soil amendments) would require active market development.

Tapping natural gas markets – These markets represent longer-term opportunities, but growing demand for natural gas represents an opportunity for biofuel derived RNG, especially when the California's Low Carbon Fuel Standard moves forward. Scale becomes a critical factor for these models.

Summary of draft findings

Notable macro and micro trends: There is general consensus across interviewees that single product digester business models will in most cases continue to be unattractive at the individual dairy level due to economics and business risk. The larger scale or expanded product base business models are generating the most support (if cautious optimism), but these models come with other trade-offs and pose new challenges. New opportunities are also expanding and diversifying the set of key stakeholders involved in driving innovation in environmental management in the dairy sector.

Drivers for the shift in stakeholders include macro-trends and micro-trends:

Macro-trends:

- Increased public awareness of sustainability
- The rise of social entrepreneurship and the "circle economy"
- Evolving GHG regulations on electricity generation and transportation fuels
- Advancements in technology- sensors, data, and knowledge management

Micro-trends:

- Increasing operational complexity
- Rise of multi-lateral business agreements
- Larger projects are increasing capital needs and capacity for financial risk management

Summary of draft findings

Third party developers and feedstock agreements: Larger and more complex projects have operational needs that require more capacity than most dairies want to take on and therefore benefit from the involvement of a third party developer. There are some larger dairy businesses whose owners are personally oriented to entrepreneurship and have the resources necessary for experimentation. These dairies may continue to lead innovation in this sector, but most dairies don't have the resources and often have less interest. Each dairy presents its own unique opportunities and challenges. Scaling up traditional models and diversifying revenue streams is economically attractive, but adds regulatory complexity and uncertainty that drive up project risks. Support from and outreach to the regulatory community to address this challenge is critical.

A case study by the Innovation Center for U.S. Dairy outlines **"Three key components of a successful third-party business model"**:

1. An agreement with the dairy farm to supply manure.
2. Performance guarantees from the digester operator and manufacturer that the digester will work as designed. If it doesn't work, the operator or manufacturer carries the risk for the initial term of agreement.
3. Most important, an "off-take agreement" — a contract with a purchaser of digester products (energy, fiber, emissions credits) to ensure there is sufficient revenue to pay loans and/or provide a return to equity investors. Off-take agreements with creditworthy companies provide added assurance that sufficient revenue will exist to pay debt service. In this project finance model, the project developer secures the agreements and takes on the risk — not the dairy farm.

Summary of draft findings

Recommendations: The shifting stakeholders and business models create both opportunity and challenges for California dairies. It is notable that most innovation in the environmental management of dairy byproducts is occurring outside of California, where real and perceived project risks are lower. Steps should be taken to reduce risks in California by improving the understanding of market opportunities, increasing awareness and vetting of potential partners and customers, and holding candid discussions about California regulations as both drivers and barriers to innovation.

Near-term recommendations:

- Map locations of potential feedstock supplier and potential energy customers or partners
- Encourage experimentation and development of nutrient capture and compost/fiber by supporting technology pilots and helping identify regulatory hurdles.
- Help develop markets for nutrient capture and compost/fiber, and vehicle fuels through dialogue with potential key customer and product trials.
- Work with DMI on large scale co-digestion in California.

Long-term recommendations:

- Work with successful digester developers (assuming they emerge) to add on nutrient capture, or compost/fiber.
- Support vehicle fuel demonstration project(s).

Draft next steps and recommendations

Business model	Summary	Next progression benchmark	Recommendations
Electric power on-grid	Power purchase agreements (PPAs) are the most common business model for revenue generation from dairy digesters, but prices have dropped over the years (below $0.09), putting digesters in the red.	Prove that the third party owner, operator business model (scale multiple dairy projects under one PPA) is viable and scalable in California.	**Near-term:** Continued tracking and pressure on CPUC **Long-term:** Work with digester developers to introduce other products (e.g., co-digestion, compost and nutrient product development)
On-site combined heat and power	Low $/kwh PPA and service connection fees drive down the margins on net metering. Cost avoidance can deliver a higher ROI if on site power and heat are needed, because farm captures value closer to retail power.	Pursue on-site combined heat and power with third party business model/dairy and factory partnerships.	**Near-term:** Map potential opportunities where dairies and heat/power users are in close proximity **Long-term:** Document and promote success of early adopters
Co-digestion	Adding organic substrates to manure digester (typically plug and flow) multiplies biogas generation 25-400%. However nutrient rich substrates can increase nitrogen and phosphorous byproduct management and permitting challenges.	Identify good dairy/processor partnerships and establish more commercial-scale pilots in California. Proactively engage state agencies to manage regulatory hurdles and reduce regulatory risk.	**Near-term:** Map potential opportunities where dairies are in close proximity to sources of other substrates **Long-term:** Document and promote success of early adopters
Regional scale digesters	Large digesters taking manure from multiple dairies can reach economies of scale; ideal if pursuing multiple revenue streams. Costs of transportation and stakeholder politics and capital risk could be deal-breakers.	Map concentrated dairy clusters, and appropriate locations for field application, build third party agreements, get regulatory buy in, and operate profitably in California.	**Near-term:** Map dairies clusters and areas where field application is possible **Long-term:** Passive support for existing industry efforts, share lessons learned from other states (WI)
Vehicle fuel	Cleaning and compressing biogas from methane digesters to produce natural gas as a vehicle fuel can tap into markets for low carbon fuels.	Secure CPUC approval for tariff, or a third party develops a CA project.	**Near-term:** Map areas where dairies and potential buyers are in proximity **Long-term:** Document and promote success of early adopters

Draft next steps and recommendations

Business model	Summary	Next progression benchmark	Recommendations
Natural gas (pipeline injection)	Condition and upgrade biogas to produce RNG that can be injected directly into natural gas pipelines, which avoids sale to utilities. However, this model is currently cost prohibitive.	Secure CPUC approval for tariff, or a third party develops a CA upgrading facility project.	**Long-term:** Not currently viable. Track natural gas markets for potential future activity.
Compost and fiber (small scale)	High value fiber products can be created with simple technologies. Revenues are derived from compost sales instead of power so methane can be flared.	Run successful pilots in California, develop and define compost market opportunities.	**Near-term:** Vet for California specific regulatory hurdles, test technology in California, and identify viable distribution channels
Compost and fiber (large scale)	Compost to create high quality fiber products. Need 4000 head dairy minimum to attract to third party. Third party uses dairy's permits for composting (WA).	Run successful pilots in California, develop and define compost market opportunities.	**Near-term:** Vet for California-specific regulatory hurdles and court third party developers
Nutrient capture	Technologies can strip ammonia nitrogen from digester effluent; ammonium sulfate can be sold as a soil amendment, creating a new revenue stream from a byproduct.	Run successful pilots in California, develop and define fertilizer or soil amendment market opportunities.	**Near-term:** - Map potential nitrate leaching risk areas to determine where dairies will be most constrained by general order. - Support trials of new nutrient capture technologies in California. - Help develop markets
Feed management	There is a potential for avoided costs, but not for additional profits. Most of the work is still in the research phase.	Measure and quantify milk productivity / enteric emissions reduction to make business case	**Long-term:** Track progress of research efforts. If significant breakthroughs are made, help spread the word

California dairy context

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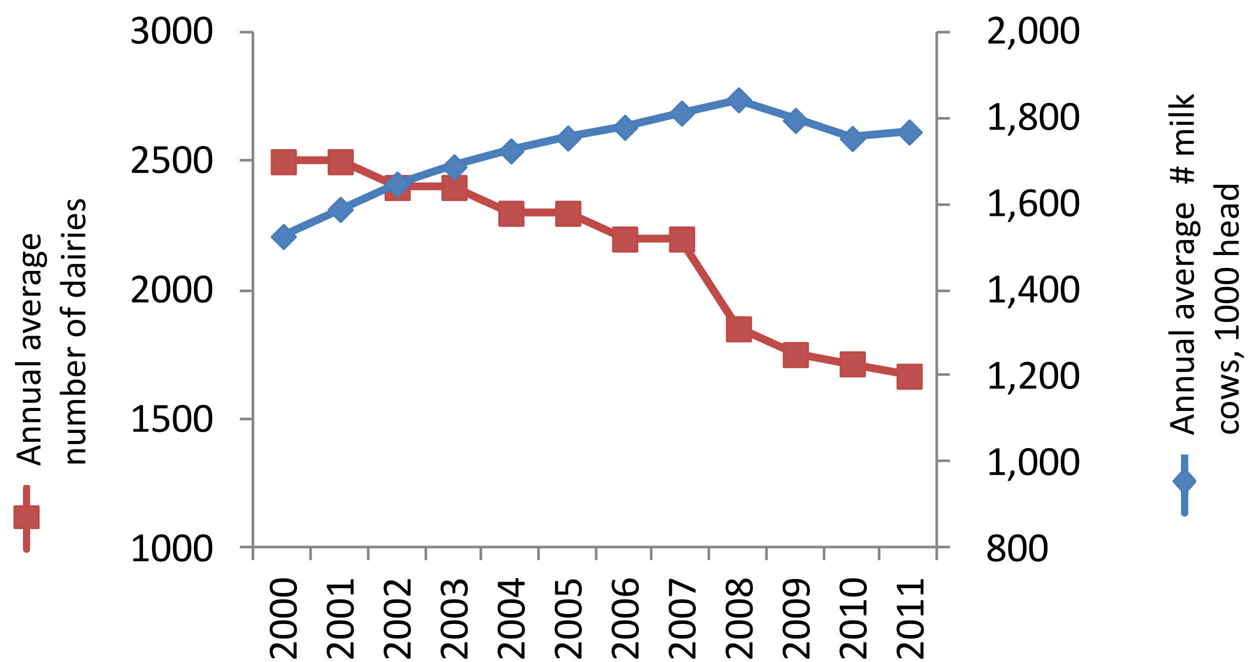
Dairy industry overview

Dairy is important to California and to the US

- Dairy products are California's leading agricultural commodity. California's dairy industry generated $7.68 billion in revenues in 2012.
- California is the nation's leading dairy state, accounting for approximately 20% of dairy production and sales in the US.
- Although the number of dairies in California has declined in recent years, the value of milk produced and the number of cows has been generally increasing.

Number of California milk cows and dairies (2000 – 2011)



Source: California Department of Food and Agriculture

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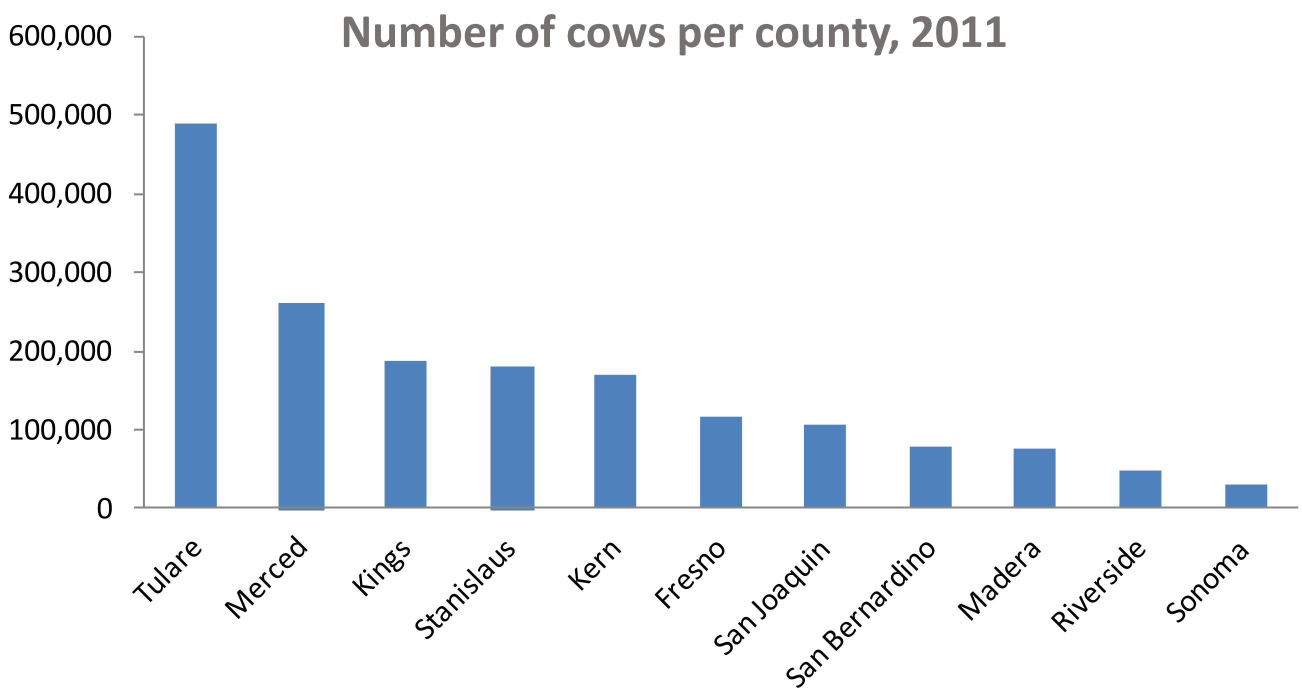
Dairy industry overview

Tulare, Merced, Kings, and Stanislaus are top dairy producing counties in California

- These four Counties account for more than 60% California's dairy cows.
- California's dairy cow population has been generally on the rise over the last decade. In 2011, the total population was 1.8 million.

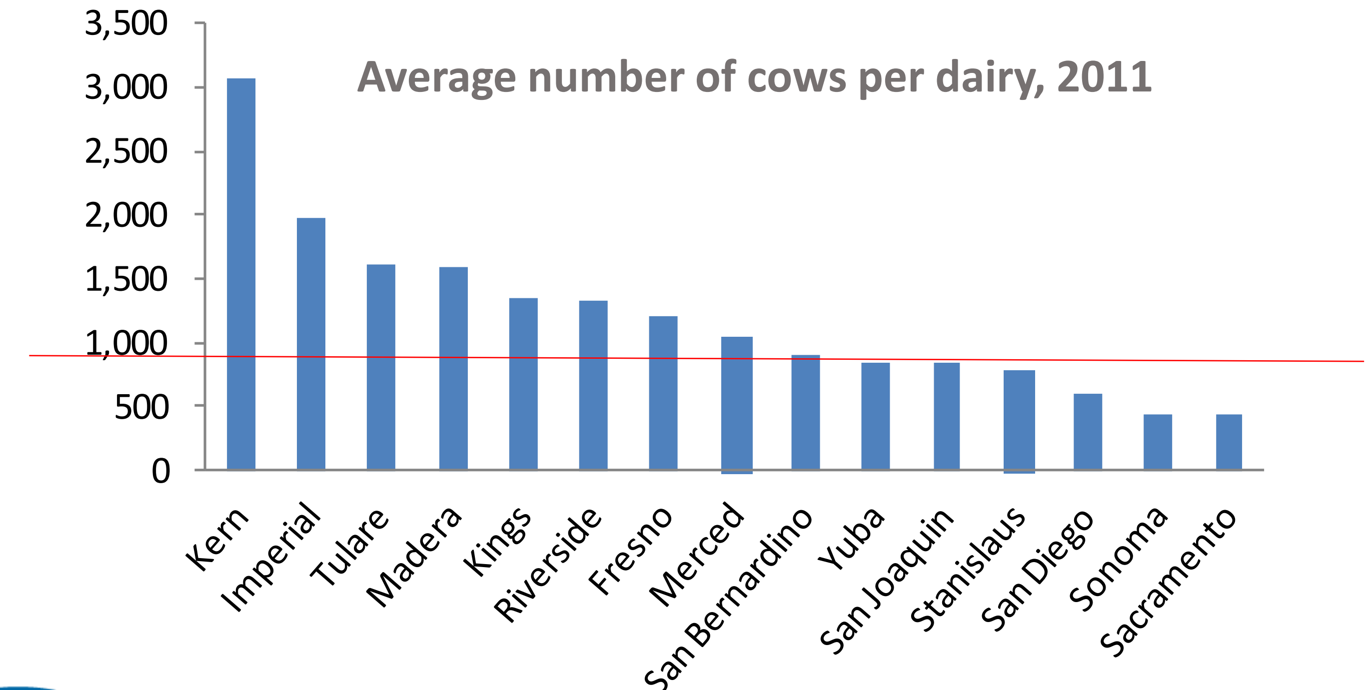


Source: California Department of Food and Agriculture

Dairy industry overview

Top dairy producers in California

- Of the top four dairy counties, Tulare and Kings have more cows per dairy than the average for California (Tulare: 1,615, Kings: 1,346, vs. ~1,100 for California on average).
- Merced and Stanislaus Counties have fewer cows per dairy than the average for California Merced: 1,044 and Stanislaus: 780 vs. ~1,100 for California on average).
- Herd sizes are increasing across the state. In 2000, 80% of California's milk cow population was found on dairies with herd sizes of over 500+ cows. By 2007, that number had increased to 91%.



Source: California Department of Food and Agriculture

Business model assessments

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Criteria definitions

Business model evaluations: CEA conducted a literature review and a number of interviews to determine, at a cursory level, the viability of several business models for environmental management of dairy byproducts in California. We evaluated the models along the following criteria.

Economics Is this model economically feasible under current market conditions?
Technology Risk Is the underlying technology mature? Applicable to CA?
Business Risk Is the business model proven? Is it operationally complex? Are there established channels and customers?
Environmental Benefits How significant are the environmental benefits?
Regulatory Risk How complex and/or stringent are the permitting hurdles?
Scalability Can this solution be adopted across CA's dairies?

Electric power on-grid

CALIFORNIA ENVIRONMENTAL ASSOCIATES

Concept – Convert manure waste into biogas and then into electricity for sale to a power utility. Effluent might run through a solid separator before entering the digester. Digester effluent is typically field applied, although depending on the digester technology, further processing could capture nutrients, produce fiber products (compost) and help with nitrogen and/or phosphorous management.

Economics

- Utility power purchase agreements (PPAs) and carbon credits are the two direct revenue streams for this model
- Capital costs: $1.5M for 100 kW
- Price volatility is low once contracts are in place, but PPA pricing ($/kWh) has been trending down. Unexplored: optimizing generation peak power pricing.
- Currently, implementation depends on large third party developers to reach good economies of scale and secure PPAs above the ~$0.12-0.28 breakeven point.

Proven success

- Livestock digesters have been implemented successfully in many states (158 dairy digesters across the US – *EPA data*), though PPA pricing is common challenge.
- A handful of developers are currently getting traction with projects in CA that include multiple digesters.

Technology risk – Digester technologies are generally mature; several models are in wide use commercially. There is some risk around the ability of the generators to meet NOx emissions standards.

Business risk– Operational complexity for a single digester is relatively low and there is a ready power market to sell into. If pricing is strong, the model can be deployed easily, but still benefits from a third party.

Environmental benefits – Provides significant methane reductions and can be coupled with nutrient capture systems, maximized with third party model.

Regulatory hurdles – Much work has been put into consolidated permitting, but NOx limits are still constraining.

Scalability – Wide scale adoption is possible if prices strong enough, third party dev. has great~~er~~ leverage.

Potential next steps

- Continued tracking and pressure on the PUC is worthwhile.
- If large scale developers are successful, they may become excellent partners for helping bring newer models to market. Look for opportunities to help large developers test and bring new technologies and business models to market.

On site combined heat and power

Concept – Convert manure waste into biogas and then into electricity or heat for use in an onsite or nearby facility that would otherwise buy that heat or power from a utility. Because the avoided costs are at retail prices, the economics can work better than the standard model of selling power to a utility at wholesale prices, if the onsite needs are great enough. There may be untapped opportunity for this model, but its applicability is limited to dairies that are co-located with cheese processors, or that are in close proximity to other facilities that could use the heat or power.

Economics

- Profitability depends on avoided cost, and therefore on the price of avoided electricity or natural gas. Onsite power can improve system efficiency by repurposing waste heat for production.
- There may be a possibility of revenues through feed-in-tariffs if supply outweighs on site demand.
- There is also a possibility of sales from nutrient or compost products from the digester effluent.
- Est. $3.5M for first 700kW, $5M (1.5MW)

Proven success

- The Gallo Dairy (California)
- Giacomini Dairy (California)
- Qualco Energy (Washington)

Technology risk – The requisite technologies are all off the shelf. As with the standard model, if the biogas is turned into electricity, there is some risk around the ability of the generators to meet NOx emissions standards.

Business risk– Risks are low if the system is contained on a single site, but more complex if it requires partnership between two parties.

Environmental benefits – Provides significant methane reductions, fossil fuel displacement, and can be coupled with nutrient capture systems.

Regulatory hurdles – Fairly straightforward, but NO_x limits are potentially constraining.

Scalability - Limited; depends on clustering of complementary facilities.

Potential next steps

- Sophisticated mapping efforts to help identify these locations may be useful to the industry. There are likely opportunities that have not been tapped between dairies and nearby demand centers.
- Outreach on the economics of onsite cost avoidance, and template approach for evaluating attractive investments.

Co-digestion

Concept – Add other substrates to manure as inputs to a standard anaerobic digester. Substrates such as crop residues, food processing waste, used fats/oils/greases, and yard waste are much more energy dense than manure and therefore drive up power output and improve the unit economics for digesters, and the potential scale for biogas in California. This model could be adopted at dairies large or small as long as the dairy can house the additional storage capacity and manage additional nutrient content of effluent. Additionally, co-digestion can be a productive use for food waste.

Economics

- Co-digesters are likely to still derive revenues from electricity sales to utilities, although if co-located with food processors they could use heat or power on-site. Thus, economics are still dependent on PPA prices.
- Added energy from organic substrates can improve the unit economics of the digester and make the system profitable at a lower PPA price point.
- Additional potential revenues from tipping fees, depending on substrate transportation costs.

Proven success

- Quasar Energy (Ohio)
- Qualco Energy (Washington)

Potential next steps

- Mapping to identify opportunities
- Partner with DMI on outreach in CA
- Identify and coordinate response to regulatory hurdles

Technology risk –Digesters are used in many industries for a wide range of substrates and substrate mixes, but contamination (chemicals/ plastics) can add risk if not managed carefully.

Business risk– At a small scale, risks are modest and depend on substrate supply. At a large scale, this model becomes operationally complex.

Environmental benefits –Large methane benefits because captures methane from multiple waste streams. Additional nutrients in the effluent may increase the burden of nitrogen on nearby farmland and will need to be carefully managed

Regulatory hurdles – High. Bringing substrates from off farm qualifies the dairy as a waste management facility, requires additional permits.

Scalability – Applicability will depend on availability of organic substrates, but there is a possibility for this model to substantially expand the generation potential for agricultural biogas.

Regional-scale digesters

Concept – With utility power purchase agreements (PPAs) so low, it is not profitable for most dairies in California to install their own digesters. However, installing a large scale digester to serve several clustered dairies could improve the economies of scale enough to make electricity sales to a utility pencil out. Manure or biogas transportation and coordination among participating dairies are complicating factors. This model is in use in both Wisconsin and Washington State. Similarly, the regional scale "hub and spoke model" distributes biogas production on individual farms and then transports the biogas to a central location for upgrading. *Note: below section reflects regional digester model in which sales are to an electric utility. Natural gas models are evaluated separately.*

Economics

- Assuming the primary revenue stream(s) for this model are the same as they are for a single dairy digester (electricity sold to utilities).
- Large scale may allow the project to secure better pricing, or simply achieve profitability due to better economies of scale.

Proven success

- Dane County (WI)
- Maas Bros (WA)

Potential next steps

- Map potential dairy clusters and appropriate locations for scaled field application, and evaluate customer base
- Evaluate economic benefits of aggregating manure or biogas physically vs. aggregating projects simply through contract agreements and combined negotiations.

Technology risk – Digester technologies are generally mature. There is some risk around the ability of the generators to meet NO_x emissions standards.

Business risk – This model is operationally complex due to the transport of manure or gas, which is costly and introduces the risk of contamination. Further, the necessary coordination of multiple dairies adds complexity and risk, even if operated by a third party.

Environmental benefits – Provides significant methane reductions and can be coupled with nutrient capture systems.

Regulatory hurdles – NO_x permits will be at least as challenging as for any digester project, perhaps more so because of the larger scale.

Scalability – Applicability will depend on geographic clustering of dairies and availability of land for field application of effluent.

Natural gas - vehicle fuel

Concept – In California, there is increasing pressure to reduce the carbon content of transportation fuels. California's Low Carbon Fuel Standard (LCFS) and the federal Renewable Fuel Standard (RFS), combined with low and stabilizing natural gas prices, is enticing fleets to consider converting to compressed natural gas (CNG) vehicles. There is interest from a few large potential buyers (e.g., High Speed Rail Authority (HSRA)) in the development of biofuels. The capital investment required is very substantial so strong customer relationships and channels need to be identified and regulatory structures need to support stable and attractive pricing. Ideal scenarios would be where fleet operator is closely involved in the project development (e.g., Ruan and Fair Oaks farms, or HSRA) from the start.

Economics

- Revenue streams include transportation fuel sales (competes with natural gas), RIN, LCFS, and carbon credits
- RIN credits have been high, but they are also volatile: $/MMBTU: RIN $4-8; LCFS $2-3; NG Spot: $2-4

Signs of success (to new to be proven)

- Fair Oaks Dairy (IN) – high profile but very new
- Hilarides Dairy (CA) has installed RNG vehicles, but is struggling to keep the model profitable

Potential next steps

- Given the scale required and the fact that ready customers have not yet been identified, this model will take some time to develop in California.
- In the near-term, look for opportunities to help create enabling conditions and dialogue with the transportation sector (CALSTART, HSRA, Ruan)

Technology risk – The technology is fairly straightforward, though costly, and the model requires both a shift in production (cleaning and compressing) and customer technology (conversion to CNG fleets).

Business risk – Customer base is not yet clear in California and the model is very operationally complex.

Environmental benefits – This model destroys methane and displaces fossil fuels. It could be coupled with nutrient recovery systems and products.

Regulatory hurdles – Regulatory complexity will be high and inflexible. LCFS and GHG cap and trade markets are drivers in California.

Scalability – This model depends on a hub and spoke digester system (dairy cluster), and nearby customer fleet(s), so opportunities are limited, but impact of one project could be very significant. May be more viable with co-digestion model (increases fuel production).

Natural gas – pipeline injection

Concept – As with the vehicle fuel opportunity, natural gas can be created from anaerobic digesters by upgrading the biogas after digestion. This gas can then be sold to the gas marketers or to end users and injected directly into natural gas pipelines. However, high capital investments are required to condition and upgrade the biogas and to cover interconnection fees. These costs are prohibitive for most single dairies. Utilities estimate 20,000 cows – or more - would be necessary to get to attractive economies of scale. A hub-and-spoke model is possible, but natural gas prices and environmental credits are currently not high enough to warrant this investment, even with better economies of scale.

Economics

- The primary revenue stream will be sales to the gas marketers or end users.
- High capital cost at $27M minimum, or fees to pay utility to upgrade.
- Revenues from environmental credits are uncertain.

Signs of success (too new to be proven)

- Biogas is being developed into CNG for pipeline injection from other feedstock sources in California (e.g., wastewater treatment plants).

Potential next steps

- There is fairly clear consensus that this model is not economically viable for dairies at this time.
- Natural gas markets and markets for relevant environmental credits should be tracked in case the economic conditions change.

Technology risk – The technology (cleaning and compressing) is fairly straightforward, but has not been widely applied to dairy biogas.

Business risk – The customer base is not clear in California and the model is very operationally complex.

Environmental benefits – This model destroys methane and also displaces fossil fuels. It could be coupled with nutrient recovery systems.

Regulatory hurdles – Regulatory complexity will be high and inflexible. Renewable portfolio standards and GHG cap and trade markets are drivers in California.

Scalability – This model depends on a hub and spoke digester system (dairy cluster), and pipeline connections, so opportunities are limited, but the impact of one project could be very significant.

Compost and fiber – small scale

Concept – Fiber can be a value added byproduct of dairy digesters or solid separators depending on the manure management system. The fiber comes from a combination of bedding, manure, and other organic substrates that are flushed or scraped from the freestalls to the digester/solid separator during removal of manure. The ability of dairies to create higher value fiber products often depends on their digester or solid separator system and manure removal system (flush or scrape). The Organix A2 (Washington State) digester is one technology that creates high-end composts (peat moss substitutes), can be deployed on small scale dairies, and could work across flush or scrape systems.

Economics

- Peat moss substitute products secure 2-4 times higher wholesale prices than compost and is lighter weight.
- Organix A2 is low cost – $270k start up for 500 cows.
- Revenue stream for dairies from product sales or cost avoidance (bedding replacement).
- Long-term potential to assist with nutrient management by reducing costs of compliance or enabling technology.
- Small scale dairies may not have resources to develop sales channels.

Signs of success (too new to be proven)

- Organix A2 (WA)

Potential next steps

- Map and evaluate customer base.
- Evaluate environmental benefits and economic feasibility for CA.
- Identify and coordinate regulatory hurdles.

Technology risk – Still in the experimental stage, so there is significant technology risk. Organix A2 is initiating a pilot in Oregon in 2013.

Business risk – Designed to be low cost, which keeps risk low. Compost markets are well established, although higher-end soil amendment markets may need more development, and sales and distribution may need to be aggregated and outsourced for small producers.

Environmental benefits – Removes less nitrogen than systems that strip ammonia from liquid effluent. The Organix A2 digester flares methane, so methane emissions reductions are less than with standard digesters; probably has NO_x and VOC emissions.

Regulatory hurdles – Need flare monitor data to determine if NO_x or VOC pollutants will be an issue.

Scalability – This technology could be applicable to most dairies in California, large or small scale, flush or scrape.

Compost and fiber – large scale

Concept – Maximizing the quality of and revenue from fiber and compost products requires attention and expertise often better achieved by a third party that brings in equipment and labor to manage the cow manure to create high value products that the third party then sells to customers retail or whole sale (and/or to the dairy depending on the feedstock agreement). Smaller dairies (less than 3,000 cows) typically don't produce enough product to attract third party interest for onsite management.

Economics

- The large scale fiber products model is operated by a third party developer.
- The third party establishes leases and feedstock agreements with dairy and carries all equipment and infrastructure costs. The third party also uses the dairies permits for composting.
- Requires ~3-4,000 head to be economically attractive to the third party developer.
- Profitability depends on feedstock agreements and hauling costs. As an example, Organix is currently selling their RePeet product for $30-60/ton.

Proven success

- Organix RePeet

Potential next steps

- Map potential dairy clusters and evaluate customer base
- Identify and coordinate regulatory hurdles

Technology risk – Organix has a proprietary but established method they have used for years - low risk.

Business risk – Compost and peat moss markets are fairly established, but channels need to be developed in California. The scale of operations implies some level of complexity.

Environmental benefits – Compost and fiber capture helps remove nutrients, but removes less than systems that can capture the ammonia nitrogen from the liquid effluent. Compost systems can work with or without a digester.

Regulatory hurdles – Composting permits could be an issue in San Joaquin Valley. Composting facilities emit VOC and NO_x, and while dairy scale composting would likely be below threshold, commercial scale would be above threshold.

Scalability – Requires large dairies or clusters of dairies, and third party developers.

Nutrient recovery

Concept – Manure is a nutrient rich substrate. Digester effluent is currently field applied, but nutrients could be captured to make high value products. Nutrient recovery becomes more difficult as particles move through the manure management system and become smaller and more diluted. California's "extreme flush" systems are especially dilute. Washington State University has discovered a nutrient recovery system that strips ammonia without adding expensive chemicals (to increase pH). The technology, which uses acid to make a liquid instead of a gas, is currently being piloted on scrape dairies. The output is an ammonia concentrate solution, though WSU is working to turn the product into a solid.

Economics

- $490k – annual operating expenses*
- $2.15M - capital expenses*
- Revenue could be as much as $130 - $180 per ton, though customer channels need to be developed

Signs of success (too new to be proven)

- DeRuyter Dairy, Washington

Potential next steps

- Map potential nitrate leaching risk areas to determine where dairies will be most constrained by California's general order.
- Support trials of new nutrient capture technologies in California.
- Help develop nutrient sales channels by engaging nurseries and fertilizer producers in dialogue.

*operational and capital costs also support fiber product revenue streams.

Technology risk – WSU's ammonia stripper seems to be the leading nutrient capture technology in development currently, though several other technologies are in the research stage. Further proof of concept is still needed. There is a serious concern that the technology may not work with California's "extreme flush" systems.

Business risk– Markets and customer channels are still nascent. Fertilizer markets are resistant to buying at small scale, so need local customer buy in. The product is a liquid, so can't be transported far – constraining markets.

Environmental benefits – Could be a very beneficial solution to nitrogen management, which is of increasing concern to California's State Water Boards, especially in the Central Valley. However, the technology could add to salinity problem.

Regulatory hurdles – This technology works in tandem with digesters, so will need NO_x permits.

Scalability - Large scale likely required for sales channels; unclear whether required for production economics.

Appendices

Interview list > Bibliography

Interviews

Allen Dusault– Innovation Center for U.S. Dairy (DMI)

Bob Joblin – Cenergy/Ag Power

Cara Peck –EPA

Carl Morris - Joseph Gallo Farms

Craig Frear - Washington State University

Dan Evans - Promus Energy

Dan Richard – CA High Speed Rail Authority

Dave Warner – SJVAPCD

Deanne Meyer - UC Davis

Dick Kempka & Peter Weisberg - Climate Trust

Douglas Meadow - Earth Renew

Erin Fitzgerald - Innovation Center for U.S. Dairy (DMI)

Gary Bullard – California Dairy Cares

Jerry Bingold – Innovation Center for U.S. Dairy (DMI)

Jim Lucas – Southern California Gas and Electric

John Bidart - Bidart Dairy / CalBio

John Boesel – CALSTART

Juan Tricarico – Innovation Center for U.S. Dairy (DMI)

Kevin Abernathy – Milk Producers Council

Paul Martin – CA Governors Office of Business and Economy (GO-Biz)

Paul Sousa – Western United Dairymen

Ray Brewer – CH4 Power

Russ Davis – Organix, Inc

Sean Hurley – California Polytechnic State University

Key Literature Reviewed

CALIFORNIA ENVIRONMENTAL ASSOCIATES

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2. "Economic feasibility of dairy manure digester and co-digester facilities in the Central Valley of California," May 2011, ESA, California Regional Water Quality Control Board, Central Valley Region.
3. "Economic study of bioenergy production from digesters at dairies in California," 2009, Princeton Energy Resources International, LLC, for CA Energy Commission.
4. "National Market Value of Anaerobic Digester Products," February 2013, Informa Economics and Innovation Center for U.S. Dairy (DMI)
5. "Making the Most from Manure," D Meyer, UC Davis, Dairy Waste Management Conference.
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8. Various Case Studies by Innovation Center for U.S. Dairy (DMI)
9. Presentations and personal correspondence from interviewees